TECHNICAL REPORT #8

Date: October 1971

From: Crawford Hill VHF Club, W2NFA

Subject: A Low Noise Preamplifier for 1296 MHz

A low noise transistor preamplifier for 1296 MHz is described in this report employing the Nippon Electric Company microwave transistor, V766A (NPN silicon bipolar transistor), in a grounded emitter circuit. A measured noise figure of 2.7 db (250'K) with 10 db gain has been achieved at 1296 MHz.

Fabrication is on glass-epoxy printed circuit board, $\epsilon = 5$, of the inexpensive 1/16 inch thick double clad type. Since the circuit impedances do not exceed several hundred ohms, and the electrical circuitry is short in terms of a wavelength, the dielectric quality of the board is of little concern. The basic structure is a 50 ohm strip line with the transistor inserted near the input connector and d-c blocking capacitors placed at the junction between coaxial connector and strip line.

No input tuning is provided since best noise performance is obtained with a 50 ohm source impedance. The actual input impedance of this transistor is about 14 + j3 ohms (series equivalent). This means that the input is mismatched for best noise performance, and that the antenna and feedline must themselves be reasonably well impedance matched around the operating frequency for optimum noise performance. The inclusion of a filter in the-input line may not realize the expected filter response because the transistor input is not impedance matched.

The output impedance of this transistor is about 150 - J100 ohms (series equivalent) and is tuned and matched to 50 ohms by means of a sliding capacitor tuner. In the finished design, the capacitor is a tab of copper foil whose area (capacitance) and position along the output line are experimentally adjusted for maximum gain at 1296 MHz. No other tuning is required. Under conditions of 50 ohm input and output, the amplifier gain will be about 10 to 11 db at midband and exhibit a -3db bandwidth of several hundred MHz.

Biasing

An important feature of this circuit is its stability (freedom from spurious oscillations) which is the function of the elaborate bias network shown on the schematic. This network consists of a 56 ohm 1/4 watt resistor in series with a resonant choke for midband. The choke, L, consists of 6 turns of #30 wire air wound on a 1/16 inch diameter form with turn spacing of about one wire diameter. The overall length of the winding is about 1/8 inch.

The small resistor is first soldered to the strip line (straight upwards away from the strip) with as short leads as possible. The top of the resistor is now a terminal point for one end of L,, the other end of L is connected to a good UHF 1000 pf bypass capacitor (low inductance). These three components provide a good high impedance choke at midband, 1296 MHz, and a relatively lossy impedance out of band.

At lower frequencies in the VHF region, the inductance is small and the 56 ohm resistor heavily loads the circuit preventing resonances of large enough Q to start oscillations. At still lower frequencies an additional RC network is provided which essentially loads the transistor with a total of 112 ohms well into the HF region. Below the HF region the 10D pf blocking capacitors roll off the external circuit response and the 5 µF capacitor prevents internal feedback. The combined action of these components in the bias network discourages external and internal circuit resonances which may cause self oscillations.

In addition, the bias network provides collector current stabilization by means of negative feedback through the 560 ohm collector dropping resistor. A 15 volt Zener regulator must be used to back up the whole network since the V766A transistor has a V maximum rating of 15 volts. The above described network is highly recommenced for all UHF transistor amplifiers.

The operating conditions for minimum NF in this circuit were 5 to 6 ma. of collector current at about 12 volts. The 25 K ohm bias adjust resistor may be experimentally set for best NF.

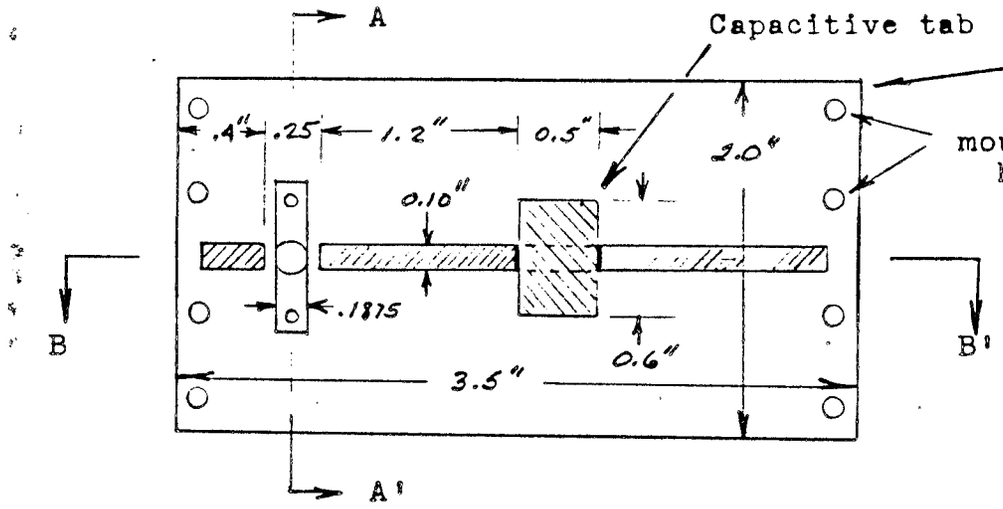
The transistor comes in a radial flat lead package with two emitter leads. The base lead is slant cut at its end for easy identification. The base and collector leads may be soldered to the strip line with a minimum of heat, low temperature iron. All leads may be shortened for convenience in mounting. The emitter clamp block should be carefully cleaned and free from filings so that the emitter can be grounded electrically secure with minimum inductance.

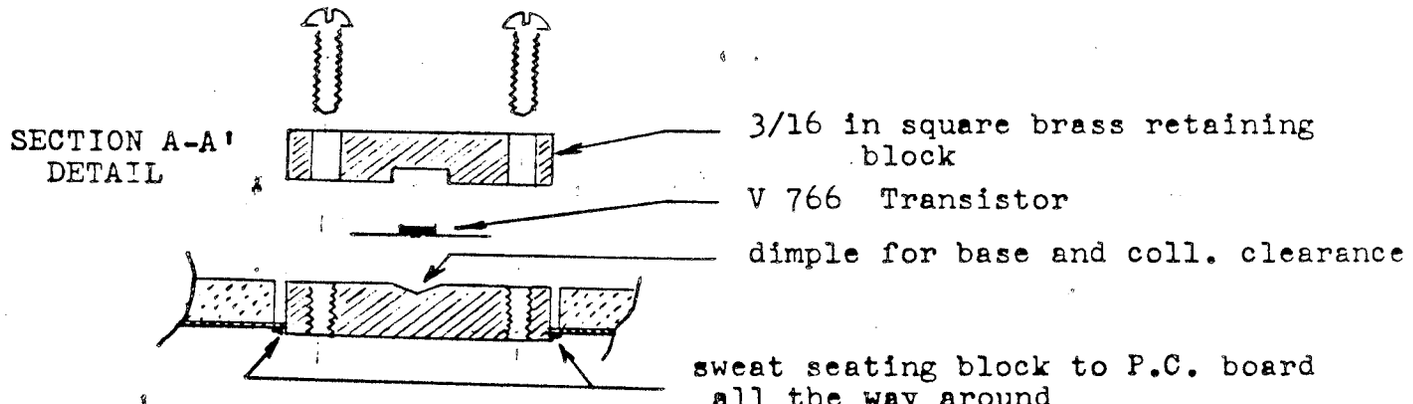
Because of the small physical size of this preamplifier, it may be conveniently weatherproofed and mounted at the feed of an antenna in order to minimize transmission line losses on receiving.

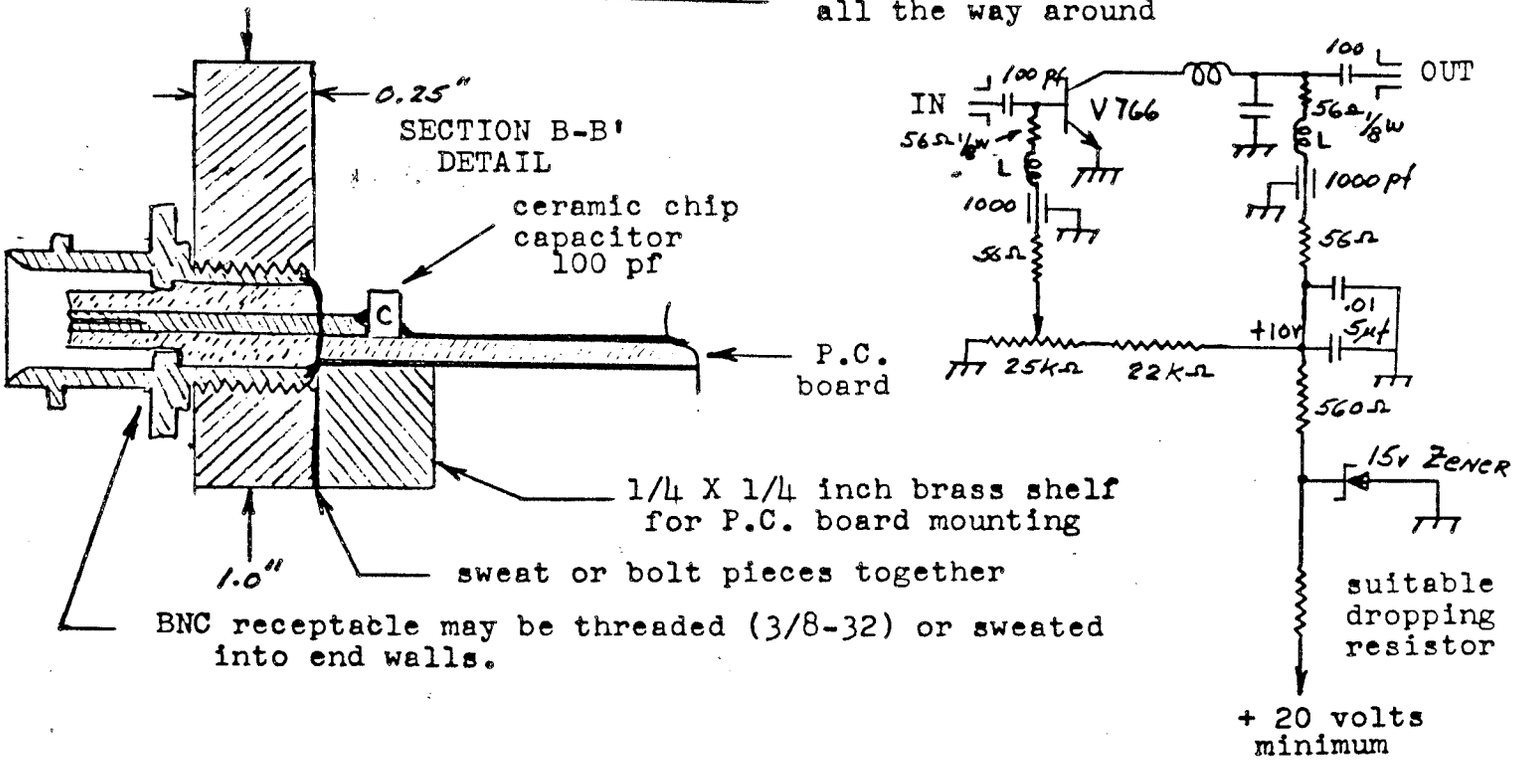
At this time, 1971, the V766A transistor may be obtained in small quantity at $26.80 each from California Eastern Laboratories Inc., 1540 Gilbreth Road, Burlingame, California, 94010, or on the East Coast of the U.S.A. from Marv Groll, 87 Terrace Hall Ave., Burlington, Mass. 018036

While the price of this transistor may seem severe, it must be pointed out that at this time, 1971, there are few if any other transistors capable of this measured NF at 1296 MHz. The only competitive preamplifier would be a mediocre parametric amplifier, which at best is far more difficult to construct and tune not to mention the need for a pump source and circulator.

A LOW NOISE PRE AMPLIFIER FOR 1296 MC/S USING THE NEC V766 TRANSISTOR



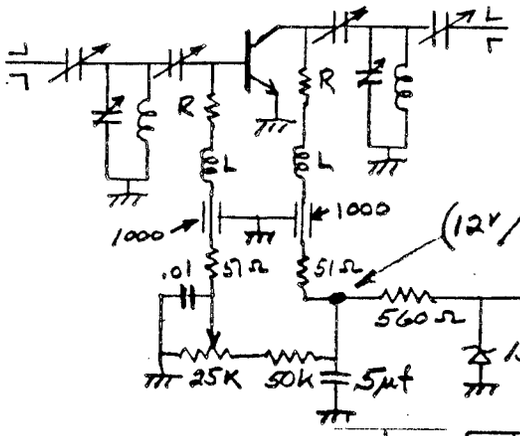


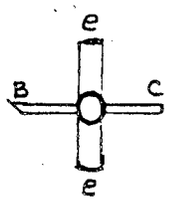


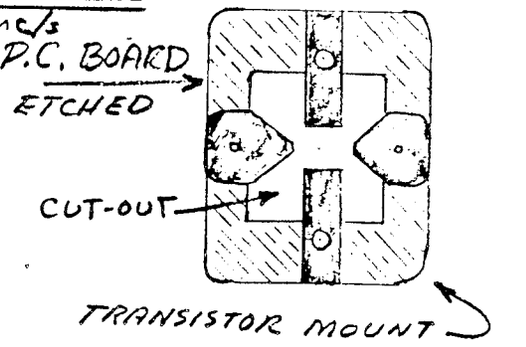
Dec, 1971
K H Turrin

1296 mc/s NARROW BAND PRE AMP

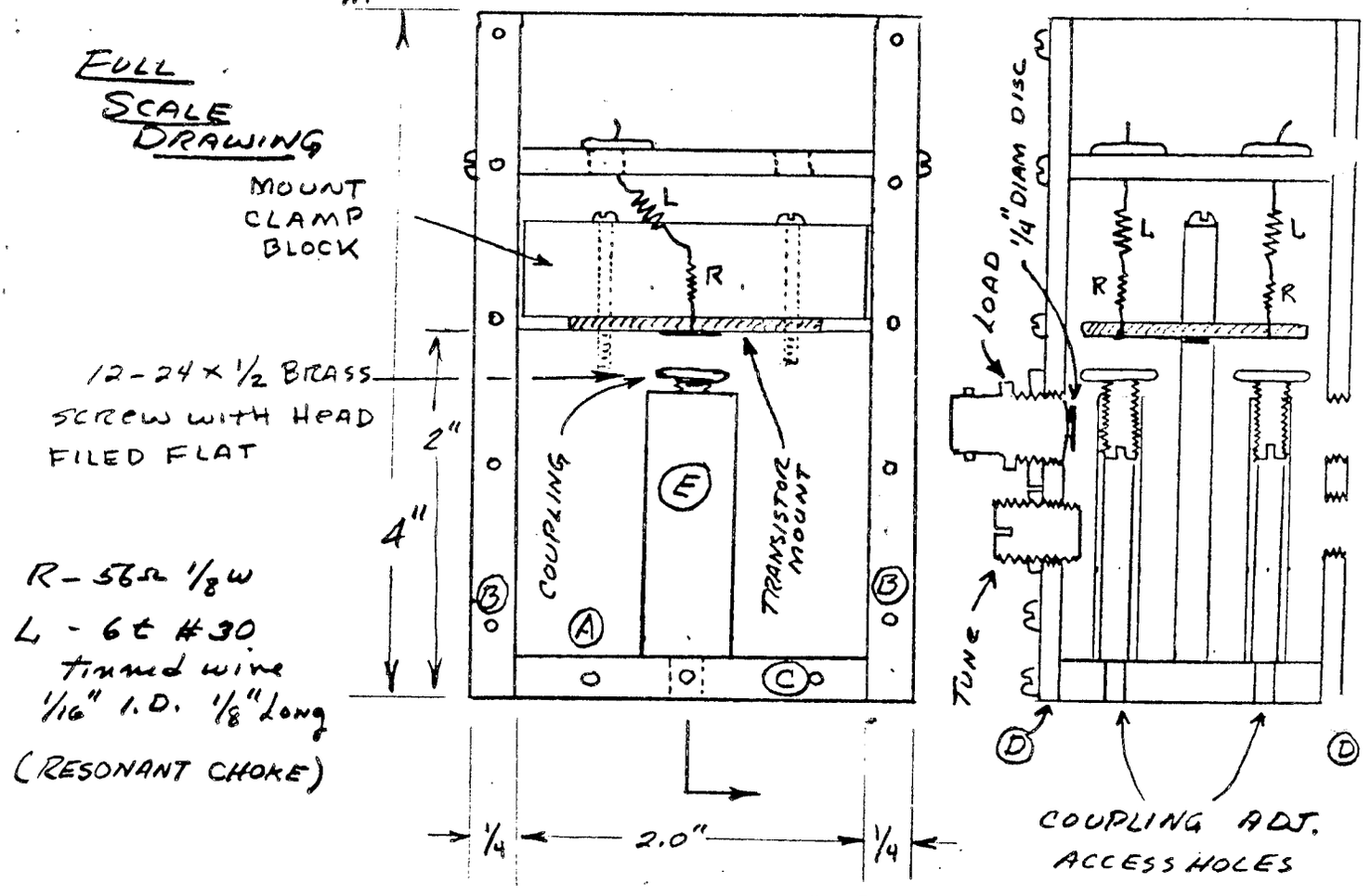
NF 3db GAIN 10 ↔ 12 DB B.W. 30 mc/s







FULL SCALE DRAWING



R - 56Ω 1/8 W

L - 6 t #30 tinned wire 1/16" I.D. 1/8" long (RESONANT CHOKE)

STOCK BRASS BARS

- (A) 3/16 x 2
- (B) 1/4 x 1 1/2
- (C) 1/4 x 1 1/2
- (D) 1/8 x 2 1/2

PARTS (A), (B), (C) & (E) ALL SWEATED TOGETHER

COVER PLATES (D) BOLTED ON

(E) 1/2 x 1/4 O.D. SILVER K-BAND WAVEGUIDE 1 1/2" LONG TAPPED 12-24 ON INSIDE of one end for coupling screw